Joint Spacetime Optimization Graph

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What Joint Spacetime Optimization Graph Specifies

The joint optimization treats position and time as coupled variables. Range observations contribute coupled spatial-temporal constraints; time observations contribute coupled constraints; the solver produces estimates that are jointly consistent.

Each variable carries a covariance against every other variable. The architecture supports queries that depend on the joint distribution rather than the marginals alone.

Why It Matters Structurally

Real operating decisions depend on joint spatial-temporal precision. 'Where will the unit be at the next time' is a joint query; the answer requires understanding the coupling between spatial and temporal uncertainty.

Joint solution produces the coupled answer structurally. The architecture supports queries that separate solutions cannot answer correctly.

How It Composes With Mesh Operation

Observations enter the joint graph as factor nodes; variables enter as variable nodes; the solver produces a joint maximum-likelihood estimate. The graph structure supports incremental update as new observations arrive.

The graph also supports lineage. Each estimate links back to the contributing observation factors; downstream audit traverses the graph to inspect the basis of any estimate.

What This Enables for Resilient Timekeeping

Surgical robotics gain spacetime-precise guidance for procedures requiring joint spatial-temporal accuracy. Defense engagement gains the same for moving-target coordination.

The architecture also supports diagnostic differentiation. When estimates fail to converge, the graph structure identifies which observation classes contribute the disagreement.